Ernest Orlando Lawrence
Berkeley National Laboratory

Strategic Facilities Plan

Prepared for the
Office of Science
U.S. Department of Energy

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Ernest Orlando Lawrence Berkeley National Laboratory

"…superb science is being done ."

FY 2002 DOE Annual Performance Evaluation and Appraisal of Berkeley Lab
January 2003

National labs encompass "a variety of fields and … acquire new ones to meet new national priorities."

Peter J. Westwick

The National Labs (pg. 298)

"The system of (DOE) national laboratories is the main American contribution to the transformation of science in the twentieth century. "

Spencer Weart,

Director of the Center for History of Physics
American Institute of Physics

"Economic investment paid intellectual and technological dividends. Lab scientists and the tools they developed changed our understanding of nature, from the structure of matter to the process of photosynthesis, from the creation of new chemical elements to the pathways of human metabolism."

Peter J. Westwick

The National Labs (pg. 2)

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Executive Summary

At Lawrence Berkeley National Laboratory (Berkeley Lab), planning and management processes focus resources to support current research missions as well as highly promising research evolutions. The Laboratory's strategic goals are consistent with the Office of Sciences vision and are addressed in the FY 2004 – 2008 *Institutional Plan*. Berkeley Lab's strategic goals are summarized in the section below. Berkeley Lab's strategic goals are solidly grounded upon cutting-edge scientific knowledge. These are achievable strategic goals in areas of national importance at the extreme frontiers of science. These strategic goals stretch the limits of scientific capability and promise outcomes of national significance. This Strategic Facilities Plan considers how Berkeley Lab meets current Office of Science missions as well as the strategic vision.

Science Vision

Berkeley Lab's work supports the Strategic Plan of the Office of Science, as we desire no less than to harness the power of the living world, design energy efficient materials for the future forged at atomic scale, measure dark energy, understand cell machinery and open new capabilities for ultrafast science, and provide powerful research facilities to advance science. Through computational science-of-scale, we will deliver new discoveries at extreme frontiers not possible through experimentation and theory alone.

The science vision for Berkeley Lab is international scientific leadership that gains revolutionary technical knowledge to benefit the nation and the people of the world. We will work jointly with the Office of Science, to refine and further Science Strategic goals with great scope and impact. These Science Strategic Goals include:

- **Designing new generations of materials with tailored properties**. Berkeley Lab is constructing a Molecular Foundry to advance the Office of Science role in the National Nanotechnology Initiative. This science research center will focus on both soft and hard nanostructured building blocks and their fabrication into functional multicomponent assemblies. The Foundry will be a user facility for visiting scientists, and will have an internal research program, a training program for students and postdoctoral fellows, and portals to other Berkeley Lab major user facilities, including the Advanced Light Source (ALS), the National Center for Electron Microscopy, and the National Energy Research Scientific Computing Center.
- **Measuring the most dominant constituent of the universe — dark energy.** Berkeley Lab is undertaking a research and planning effort for an astrophysics satellite program that will define the fundamental properties of the universe through the observations of supernovae. The effort stems from mounting supernova evidence that the expansion of the universe is accelerating, perhaps driven by an unseen dark energy. The observation of sufficient numbers of supernova events is necessary to measure the mass density, energy density, and curvature of the universe, and to address this newly discovered dark energy. The international collaboration for this satellite mission will require resources for planning and experimental development during the next several years, in advance of project implementation.
- **Understanding the machinery of cells at the most fundamental levels.** In the era that follows the sequencing of the human genome, a new biology program for the Office of Science is directed at developing

more predictive and quantitative understanding and control of microbiological systems. This includes characterizing the regulatory networks of microorganisms and creating data-driven, validated models of biological responses in environments of critical importance to DOE. Berkeley Lab's efforts are directed towards an integrated program of environmental microbiology, functional genomic measurement, and computational analysis and modeling to understand the basic biology of microbial systems and to restore contaminated environments. This work complements and supports National Institutes of Health (NIH)-supported efforts aimed at understanding molecular mechanisms of DNA repair, cancer, cell-cell interactions, and aging.

- **Enable Scientific Discovery through Advanced Computing.** Major scientific discoveries have depended on the National Energy Research Scientific Computing (NERSC) Center, including the data computations that revealed that the expansion of the universe is accelerating and that the Universe is "flat." Berkeley Lab has joined with other national laboratories in partnerships with computer manufacturers to develop a new generation of computer architectures tailored to scientific applications. New architectures offer the promise of the most powerful data analysis and simulations possible, addressing DOE scientific demands including those coupled to energy security and the environment, living systems, and the origin and fate of the universe. NERSC Center can address these scientific demands with new architectures that can yield high cost-effectiveness in the 150 teraflop range.
- **Advancing science at ultrafast scales.** Berkeley Lab has been working with the community of scientists interested in ultrafast phenomena to develop powerful scientific tools to address this area of science. Berkeley Lab has conducted the studies and preconceptual design work to define the parameters for a Linac-based Ultrafast X-ray Source that would be a powerful discovery tool for the field of ultrafast science. The prospect of high intensity, coherent, tunable, synchronized x-rays having durations in the femtosecond range may now open this regime to extremely productive investigation. Berkeley Lab with other organizations hosted a national symposium that outlined the breakthroughs possible and the instrumentation that could advance the emerging science.
- **Operate national experimental facilities at the scientific frontier.** The focus of this goal for national experimental facilities is to develop and maintain U.S. leadership in the physical sciences and natural sciences, with a focus on Advanced Light Source (ALS) science and facility performance. The Laboratory will continue to expand the user program at the ALS, and upgrade the facility to keep it at the cutting edge. The improvements will significantly improve beam intensity, beam current continuity, and other operating characteristics.

Laboratory Mission and Role

Results-oriented performance in the DOE's scientific mission drives Berkeley Lab. Berkeley Lab is a multiprogram national research facility and an integral element of the Department of Energy's National Laboratory system. Berkeley Lab's programs support DOE's mission to maintain "a secure and reliable energy system that is environmentally and economically sustainable" and to ensure "continued United States leadership in science and technology," as stated in DOE's *Strategic Plan*. These programs also support the Comprehensive National Energy Strategy to "work internationally on global issues," to "improve the efficiency of the energy system," and to "expand future energy choices through wise investments in basic science and new technologies."

Berkeley Lab's principal role for DOE is fundamental science; for example, developing powerful experimental and computational systems for exploring properties of matter, deepening our understanding of molecular interactions and synthesis, and gaining insights into biological molecules, cells, and tissues.

Berkeley Lab is a major contributor of research on energy resources, including the earth's structure and energy reservoirs, fusion, combustion of fuels, and keys to efficient energy storage and use. In addition, Berkeley Lab is extensively involved in environmental research, including subsurface contaminant transport, bioremediation and indoor air quality.

Berkeley Lab's mission statement, as stated in its FY 2004–2008 *Institutional Plan*, articulates four distinct Laboratory goals that support the DOE mission; Berkeley Lab:

- Performs leading multidisciplinary research in the computing sciences, physical sciences, energy sciences, biosciences, and general sciences in a manner that ensures employee and public safety and environmental protection.
- Develops and operates unique national experimental facilities for qualified investigators.
- Educates and trains future generations of scientists and engineers to promote national science and education goals.
- Transfers knowledge and technological innovations and fosters productive relationships among Berkeley Lab's research programs, universities, and industry.

User facilities at Berkeley Lab include the Advanced Light Source, National Energy Research Scientific Computing Center, National Center for Electron Microscopy and the Biomedical Isotope Facility.

Site Development Planning for the Research Mission

The Lawrence Berkeley National Laboratory's results-based management efforts are directed towards advancing DOE's overall strategic interests and towards the Office of Science's goals to advance the frontiers of the physical sciences and the areas of the biological, environmental and computational sciences that deliver the scientific knowledge and discoveries for DOE's missions.

The Laboratory directly addresses the Department of Energy's goal to provide world-class research facilities and essential scientific human capital to the nation's overall science enterprise. Berkeley Lab operates and develops the site to:

- Stimulate and foster a collaborative, world-class scientific work environment that attracts and retains highly qualified professionals.
- Accommodate flexible, state-of-the-art facilities and infrastructure appropriate to Berkeley Lab's research roles for DOE.
- Support the growing user community at the Laboratory's scientific facilities.
- Promote its unique setting and outdoor spaces to maximize opportunities.
- Welcome users, visitors, and neighbors in an enabling, efficient, safe, and attractive manner.

The Laboratory's Strategic Facilities Plan is based upon the requirements of the researchers. The Laboratory's Facilities Division works with the research divisions to project both short and long-term building and infrastructure requirements.

As a multiprogram laboratory, Berkeley Lab's scientific mission extends across a variety of facility types and encompasses a very large community of "users", members of academia and industry who utilize the Laboratory's specialized facilities and engage with the Laboratory's unique scientific expertise and capabilities.

Research-driven building and utility infrastructure data and trends are evaluated against current and projected building capabilities and population projections. The functional capabilities of the current buildings have been assessed; these capabilities have been assessed relative to the near and long-term building requirements of the researchers.

The Laboratory plans for three types of facilities projects in order to address these research mission requirements:

- Appropriate Preventive Maintenance and Upgrades.
- Programmed Demolition of Retired Facilities

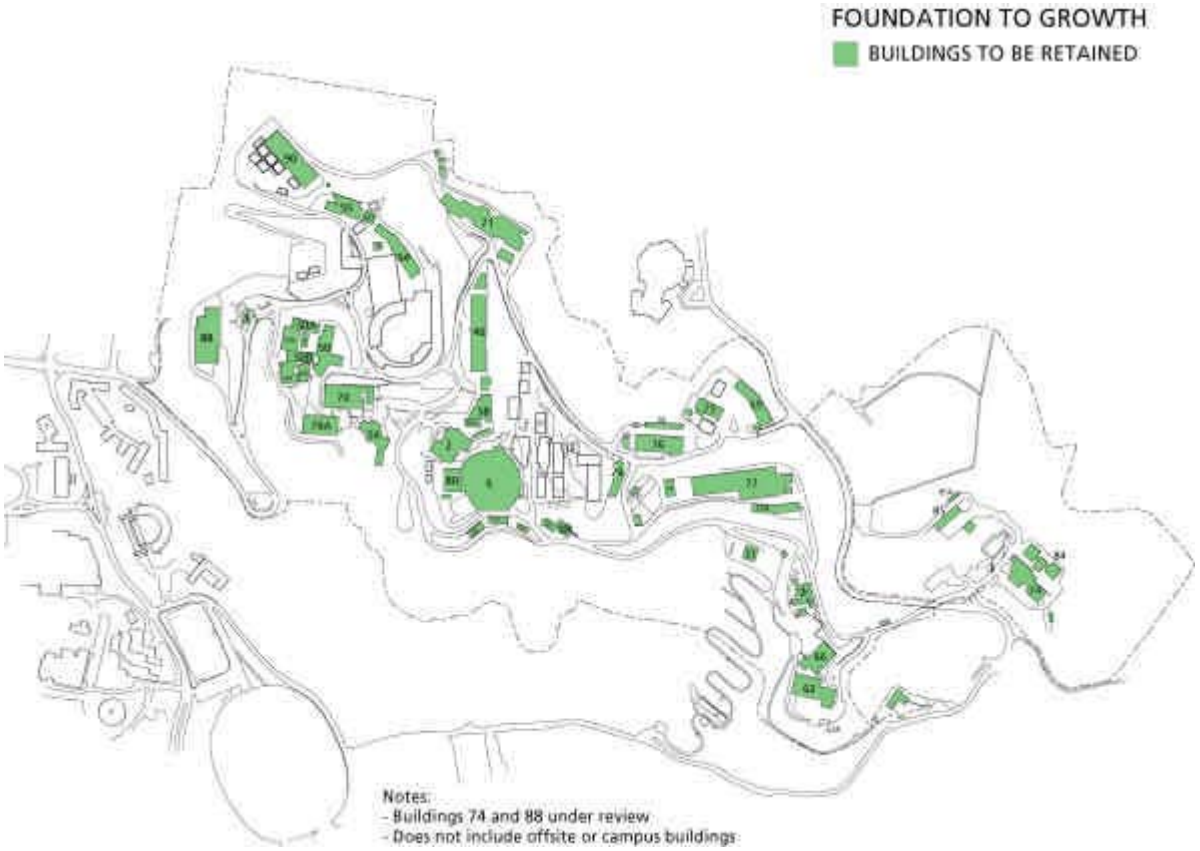
- Construction of Specific New Buildings

Timely preventive maintenance is the basis of research longevity in science suitable buildings. Berkeley Lab matches data regarding building use and future research requirements to preventive maintenance to optimize investment of funds. Where upgrades to existing system equipment are needed to better serve mission requirements, such investments are appropriate and maximize both maintenance and operational investments. Unfortunately, current "color of money" limitations inhibit such wise investments in some instances.

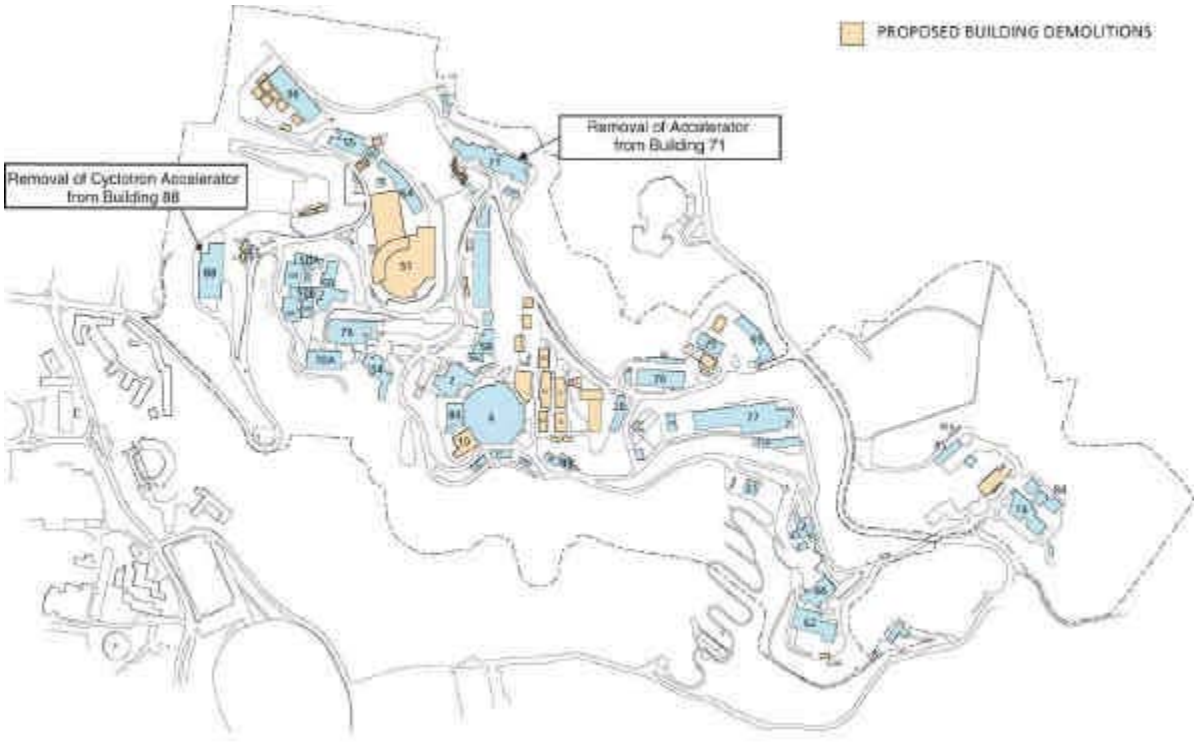
When buildings cannot cost-effectively be adapted to the requirements of modern science they are considered for other uses (e.g. storage) and for demolition/replacement. Limits to cost-effective space adaptation and mission growth drive the need for new buildings and the replacement of those buildings that can no longer meet functional requirements.

Map 1 below identifies the Laboratory buildings that are to be maintained and upgraded.

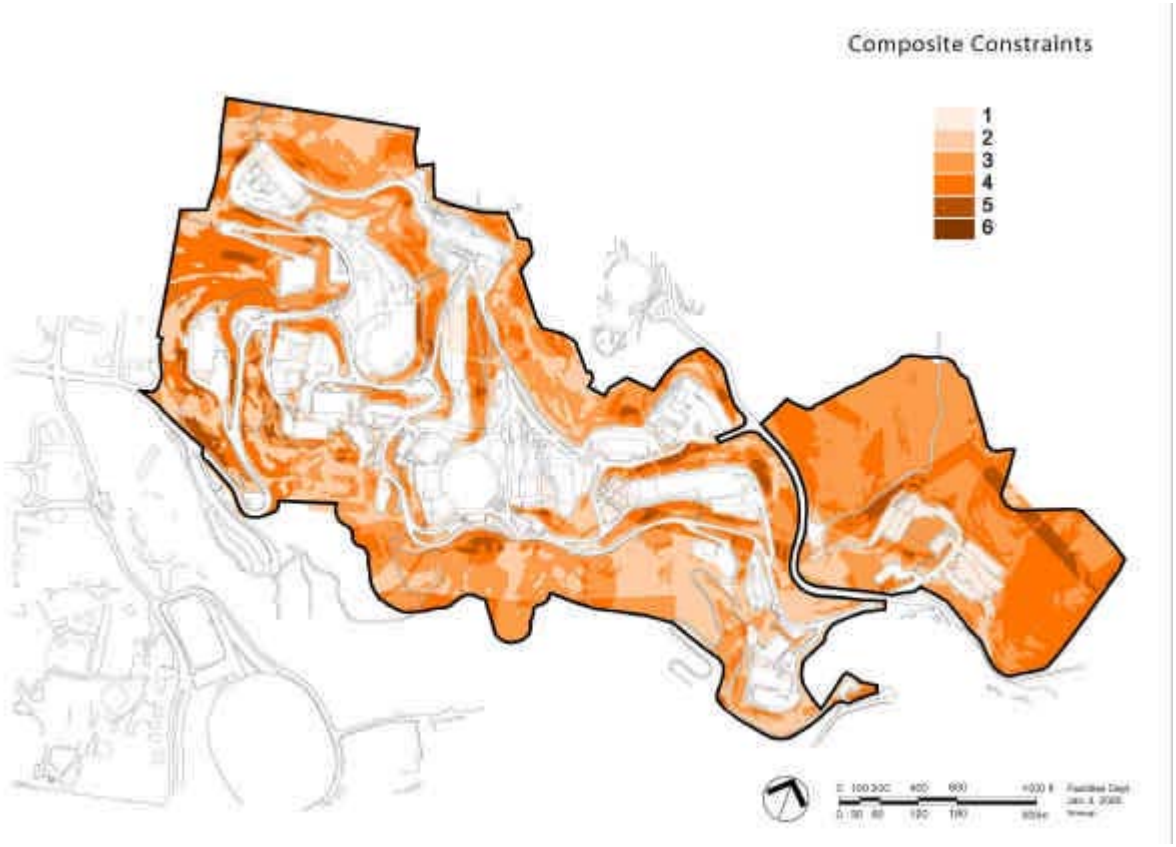
It is clear that a number of WWII-era, special purpose structures and many trailers can not be cost-effectively adapted to meet the needs of modern science. Reuse of these building sites to construct new modern structures not only provides modern high-caliber laboratory space for the immediate mission but also supports a continuing program of building maintenance and adaptation aimed to obtain maximum value from all investments made to the scientific infrastructure. These buildings account for forty percent (40%) of the Laboratory's deferred maintenance backlog. These funds could be better invested in buildings to be retained in mission service. Map 2 below, identifies the buildings to be demolished.


FOUNDATION TO GROWTH
BUILDINGS TO BE RETAINED
Notes:
- Buildings 74 and 88 under review
- Does not include offsite or campus buildings

Map 1


PROPOSED BUILDING DEMOLITIONS
Removal of Accelerator from Building 71
Removal of Cyclotron Accelerator from Building 88

Map 2

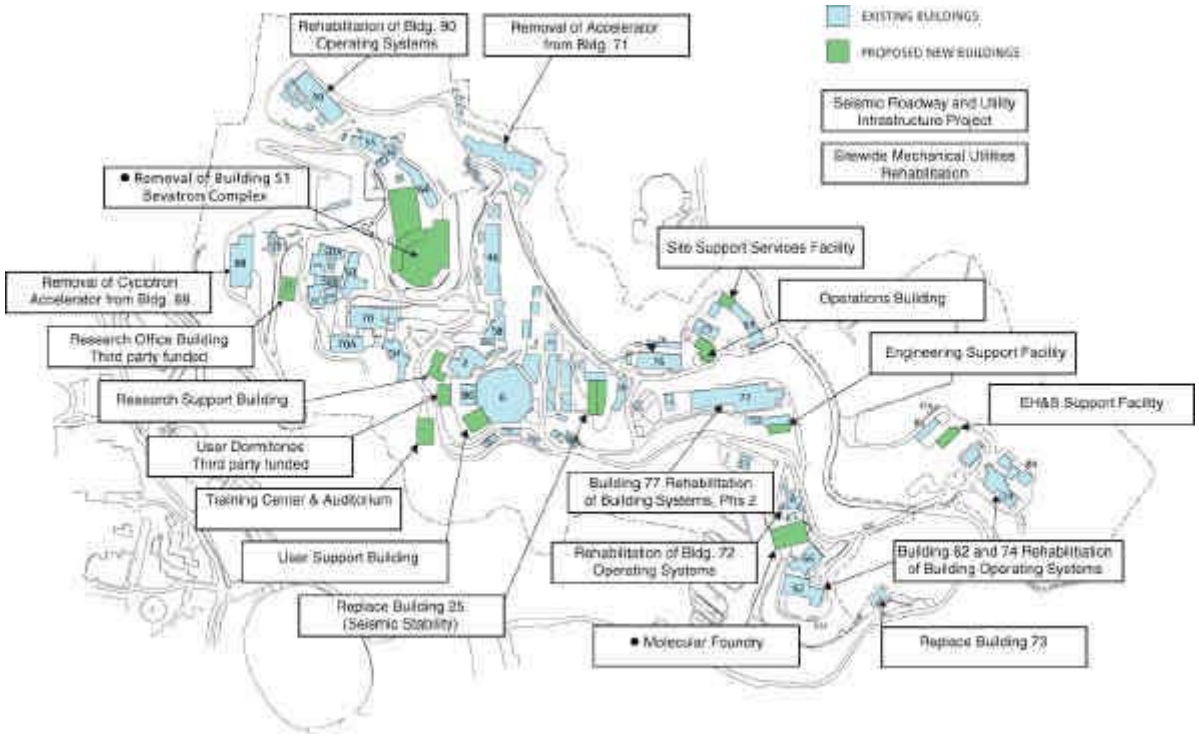


Map 3

The regular infusion of new research laboratory buildings is fundamental to the over all strategy of maximizing use of all space. The research and infrastructure requirements of each building proposal are reviewed in a site selection process. Siting at locations between buildings or on the site of buildings which have been demolished are considered, as are new development sites. In general, preference is given to sites within the existing development framework of the Laboratory infrastructure. Sites outside the existing infrastructure system are considered as research program requirements dictate. In these cases, the Laboratory uses Geographical Information System to facilitate consideration of siting in these areas. The Geographic Information System facilitates identification of environmental and other factors involved in the development on any of these lands. A composite constraints map from the Geographic Information System is presented below. In general, areas of lighter coloration have fewer constraints (see Map 3). A siting map of currently proposed projects follows as Map 4.

Facilities Maintenance and Upgrades

Most of the Laboratory's buildings can continue to meet the evolving DOE mission for many decades provided they are maintained and timely upgrades are made to these facilities. Maintenance alone does not itself ensure that current buildings are or will be suitable for the evolving needs of modern science in the coming decades. However, timely upgrades of building systems generally provide the most cost-effective method to provide scientific space which is fully capable of meeting evolving and ever more demanding research requirements. In order to make timely improvements to the current Laboratory buildings, an increase in the



Map 4

level of GPP funding is required. Under DOE regulations, this is the Laboratory's sole source of capital funds with which we may accomplish small and moderate scale facility improvements. Such small and moderate capital improvements are fundamental to our ability to adapt space in older buildings so that they serve modern scientific requirements. The GPP funds are a critical factor in our ability to extend the useful scientific life of many existing buildings. An increase of funding to $10.5M/year would be prudent –serving both to address a pressing backlog of such projects and to allow the Laboratory to seamlessly and cost-effectively support the DOE's evolving missions.

A small number of buildings and infrastructure systems require major upgrades in order to continue to meet mission requirements over the next decades. These buildings and infrastructure systems are otherwise in fine condition and can serve the mission for many additional decades with a one-time investment of Line Item Funds. Of particular interest are two near-term projects; a proposed FY 2006 project to upgrade Building 62 and a proposed FY 2007 project to improve the roadway and utility infrastructure in order to minimize damage and meet service restoration requirements after a seismic event.

In some cases large scale renovations of building are required to meet current and future research requirements. When the building is otherwise sound, such investments can add many additional decades of service to a structure and do so a fraction of the cost of constructing a new building. The Laboratory has proposed a few projects of this size as SLI Line Item Project proposals.

Removal of Retired Facilities

Consistent DOE Operating Funding is at the base of the Laboratory's efforts to remove retired facilities. facilities that were constructed to serve missions that are no longer supported by the DOE and which are not cost-effective or suitable for adaptive reuse. These facilities are located at four "re-development" sites; two of

these sites require only removal of abandoned accelerators and related equipment as the buildings are fundamentally sound and adaptive reuse is practical, the other two sites are full demolition projects and will allow for development of new modern research facilities.

88-Inch Cyclotron ($19M – 50,000 gsf of building space reclaimed for use) - The Laboratory supports the continued operation of this accelerator facility. However, should DOE determine that it is no longer needed for this mission, LBNL seeks support from DOE to remove the accelerator and related equipment so that this building can be adapted for reuse to serve other mission purposes. The building has been surveyed and found to be in very good condition and, after removal of the accelerator and related equipment is suitable for adaptive reuse for other DOE missions. nuclear chemistry programs. It is expected that this clearance effort would cost approximately $19 million and could be accomplished in about 4 years. The Laboratory is exploring reuse options for this building which is located on a prime site adjacent both to the main entrance to the Laboratory and to the very active Building 50-research complex.

Building 71 Accelerator ($3M – 20,000 gsf of building space reclaimed for use) – DOE operations at this accelerator ceased ten-years ago and the accelerator portion of this otherwise useable building has been unusable for this past decade. This project will remove the accelerator and related equipment so that this building can be reused for other mission purposes. It is estimated that this clearance effort would cost approximately $3 million and could be accomplished in one year.

Old Town ($10M – 100,000 gsf of buildings demolished produces a 5.5 acre development site for modern new buildings) – The WWII-era buildings of the "Old Town" area of the Laboratory are not suitable for modern science and are no longer fully functional. The average age of these scientific buildings is 55-years; they have served the mission well and are now slated for removal to make a large 5.5-acre site available for modern research structures. These buildings are typically small wooden structures, yet they occupy prime sites that can be redeveloped to accommodate larger modern research facilities in line with current and future DOE mission requirements. The Laboratory proposes a retirement schedule for these structures that allows current building occupants to be relocated into more modern and appropriate space. The Laboratory proposes to reuse these building sites to construct modern multistory research facilities at these locations in order to seamlessly meet DOE's mission requirements for many decades. The proposed work includes demolition of Buildings 4, 5, 7, 14, 16 and 25 as well as smaller structures in the area, termination of utilities such that future projects can tap into the Laboratory's main infrastructure, and any required decontamination of the sites. The cost estimate is under review and may be updated in the next Strategic Facilities Plan.

The Bevatron ($74.45M – 172,000 gsf of buildings demolished produces a 4.4 acre development site for modern new buildings) - This current project consists of dismantling, demolishing, and any required decontamination of the Building 51 Bevatron Complex. The work includes removal of the accelerator, shielding, buildings, related structures, and surface foundation. This site will then be productively used to meet DOE's emerging scientific missions. The abandoned Bevatron accelerator cannot be adaptively reused and should be removed. The Bevatron comprises 172,000 gsf of Laboratory space, about 10 percent of the space on the main site. Since it ceased operation in 1993, the Bevatron has been largely abandoned by the Department of Energy, with very limited funds for its dismantling. A key element of the facilities planning is the deconstruction of the Bevatron facility so this costly maintenance nuisance and impediment to site management can be eliminated, and the site used for DOE research and Laboratory needs. The Laboratory has provided a multiyear dismantling plan for the Bevatron. With funding consistent with the plan, the project will be completed in the 2015 time frame. It is possible, however, to accelerate this demolition schedule and complete demolition in the 2010 time frame; under this alternative scenario, the total project cost can be reduced.

New Buildings and Infrastructure

Research – The immediate development priority is construction of the Molecular Foundry. Construction is slated to begin in January 2004. The Laboratory is highly supportive of DOE's evolving Genomes to Life program and is reviewing the facilities requirements for this program. The Laboratory is also working to develop a proposal for the LUX accelerator. These later two projects are under development and will be added to the narrative and Appendix B in a future Strategic Facilities Plan. Such projects also have strong connections to exceptional and evolving research programs in the scientific community of this Office of Science Laboratory.

Science Lab Infrastructure (SLI) – The immediate development priority is construction of the User Support Building. This building will directly support all visiting scientists using the Laboratory's National User Facilities. This new facility will provide users with office and laboratory space as well as common space. The building is sited adjacent to the "civic center" area of the Laboratory where visitors can access dining, banking, transportation and other amenities. The SLI program is a fundamental element of the DOE structure and is critical to supporting Berkeley Lab in meeting the infrastructure and building needs of the larger Laboratory community.

Site Capabilities and Development Priorities

Berkeley Lab's asset management programs are directed to attract and retain the outstanding scientific talent to address DOE's missions. Berkeley Lab's continuing record of performance and its unique geographic location are key elements in the Laboratory's success in this arena.

Berkeley Lab is unique among the national multiprogram laboratories in that it is located in the center of one of the nation's premier research and development hubs. (see Figure 1) The physical presence of an Office of Science facility in this internationally recognized scientific/economic region provides unparalleled

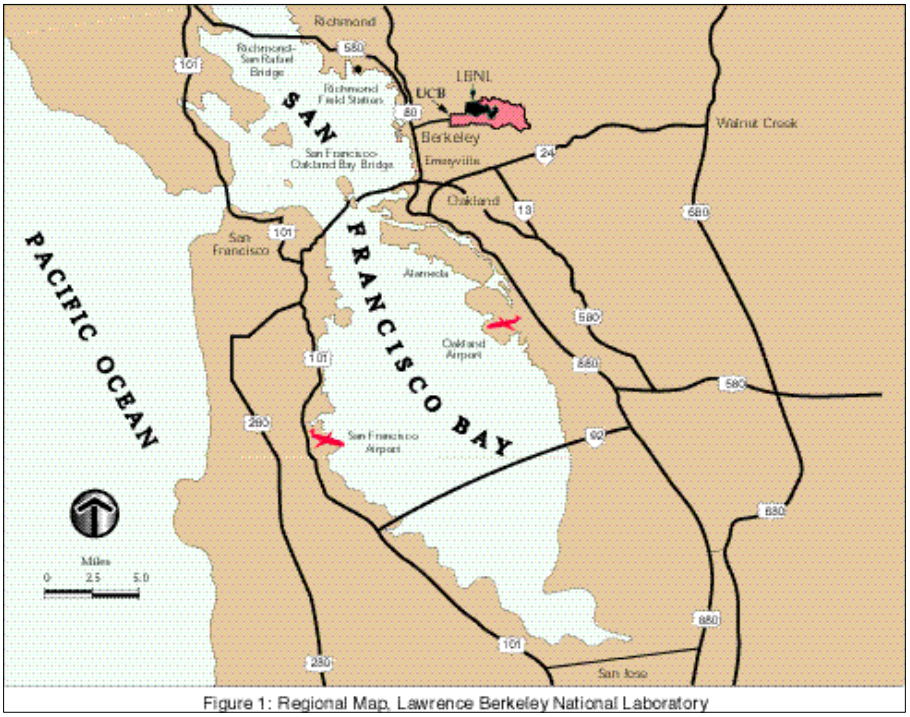


Figure 1: Regional Map, Lawrence Berkeley National Laboratory

Figure 1. Regional Map, Lawrence Berkeley National Laboratory

opportunities for scientific interactions and economic stimulation.

Berkeley Lab is located in a non-urban setting immediately adjacent to a preeminent research university–-an environment that is particularly conducive to concentrated scientific focus. Berkeley Lab was the first of the National Laboratories, established at its hillside location above the University of California, Berkeley campus in 1939.

Berkeley Lab can accommodate the research functions required to fulfill the Laboratory's Science Vision. Indeed, most Laboratory buildings are fundamentally sound and with timely upgrades are fully capable of meeting the major portion of the mission requirements. With programmed demolitions of buildings which can not be cost-effectively upgraded to meet future mission needs, and the construction of new research buildings, this Laboratory has the capacity to address the DOE's evolving missions through the 21st Century.

The Laboratory has a sustained history of scientific leadership in the performance of its missions over the years. The evolution of the Laboratory is summarized in Figure 2.

Berkeley Lab's 82-hectare (200-acre) main site encompasses 1.77 million gross square feet (mgsf). In 2003, there were 107 buildings of conventional construction and 53 trailers at the main site. Additional space on the UC Berkeley campus includes 75,000 net square feet (nsf), and 337,000 gsf are located in leased buildings in the cities of Berkeley, Oakland, and Walnut Creek (leased gsf includes 45,000 gsf of exterior warehouse space). (See Figure 3)

Laboratory Site Development Planning

The Laboratory's Strategic, Space Management and Site Development planning programs are closely linked and coordinated. They are aligned and focused to achieve the facilities necessary to sustain the Laboratory's results-based research for the DOE mission. Supporting sustained scientific advances at Berkeley Lab is a site development planning program that is focused to:

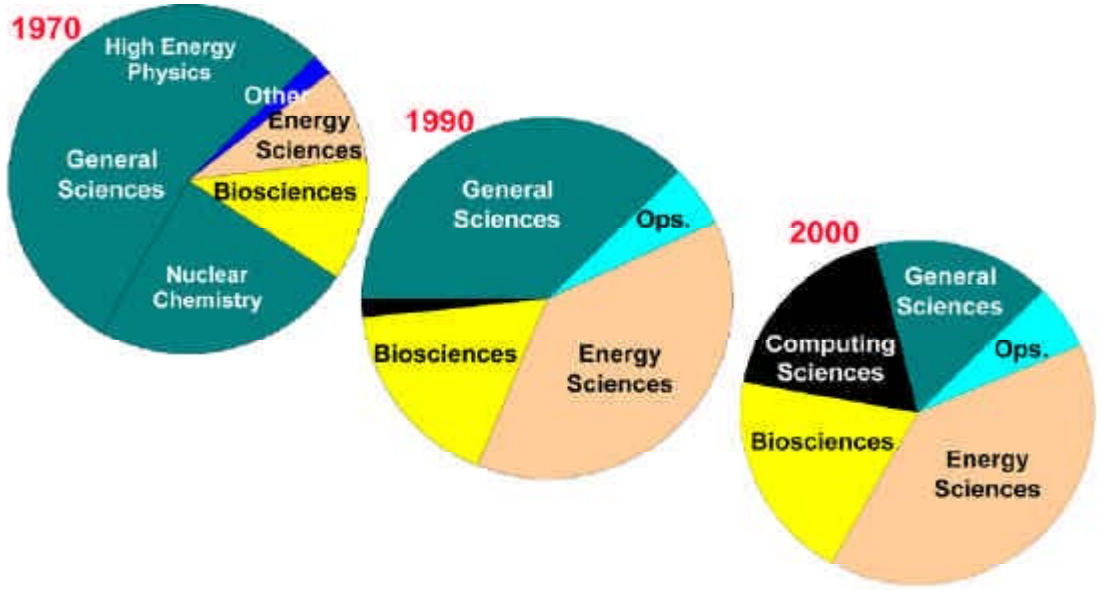


Figure 2 Evolution of the Laboratory

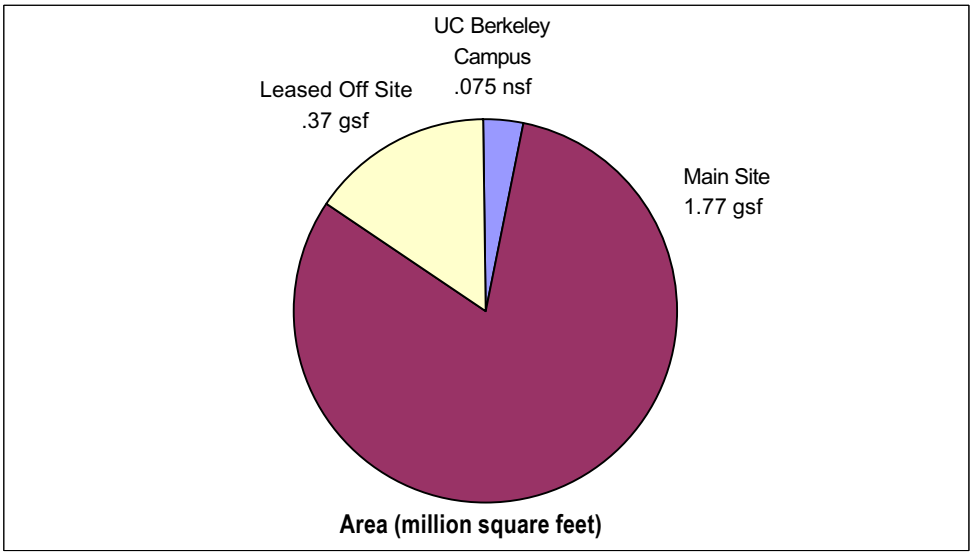


Figure 3 Location of Laboratory Space

- Ensure investments are made to the utility infrastructure in order to provide a reliable platform for leading edge science.
- Plan building upgrades and replacements coordinated with programmed maintenance to ensure that the infrastructure continues to meet research requirements.

In 2000–2001 a "Building Massing" analysis of each area of the Laboratory was conducted and the development potential of the entire site considered (both redevelopment and new sites). This analysis was discussed with the research leadership.

In 2002, individual meetings were held with each of the research units, initiating a process that will ensure that their building development needs and priorities are being appropriately addressed. The meetings involved Strategic Planning, Space Planning and Site Development Planning staff in a coordinated process. This planning process is at the basis of the 2002 and 2003 Strategic Facilities Plans. In mid to late 2003, Site Development Planning will meet with the individual Divisions to review development scenarios.

For the planning horizon of this plan, Berkeley Lab's mission will be sustained in fundamental research, energy resources and environmental quality. Berkeley Lab does not anticipate major growth in programmatic activity outside of DOE mission initiatives. On the other hand, advances in the Laboratory's scientific programs and the emerging developments in DOE program areas are expected to sustain key trends, such as: a growing population of users at the Advanced Light Source and other user facilities; more powerful computational capabilities integrated with science applications; increased scale of new bioscience programs in proteomics, structural biology and functional genomics, and a new understanding of the universe, matter and energy through advances in astrophysics, detectors, and accelerator science. In addition, energy and environmental issues will reaffirm the research focus on inertial fusion energy science, carbon sequestration, and reliability-of-electric-power and energy-efficiency research as the nation addresses its energy supply problems.

Both the current roles and the anticipated changes—especially in growth of nano-scale science, advanced instrumentation, computation, and the new biology—call for strategic investments and renewal of scientific and support infrastructure that is essential for Berkeley Lab to meet its current and anticipated mission and program obligations. Major new scientific instrumentation and

experimental programs, including LUX, a major new accelerator, offer the prospect for significant scientific and economic benefit consistent with Berkeley Lab's current research expertise. Because of their size and uniqueness, such significant initiatives are planned and advanced through national and international scientific forums. The Laboratory has and will also continue to advance new, novel and innovative accelerators, x-ray sources, and other instrumentation through its ongoing programs.

Some program growth and redirection may occur in selected areas, such as additional operations to accommodate the expanding user communities, current and anticipated national initiatives such as those in nanoscience and computing and, potentially, other areas. Each of the strategic facility investments called for in this plan are result-driven and directly tied to Berkeley Lab's service to DOE scientific missions.

Ten-Year Facility Development Program

The Laboratory's Ten-Year Facility Development Plan is based upon the strategic scientific vision of the Laboratory and the specific infrastructure and facility requirements of the researchers. The Laboratory plans for three types of projects in order to address the site development requirements of these research missions in an integrated and highly cost-effective manner:

- Appropriate facility and infrastructure upgrades coupled with preventive maintenance and an active space management program
- Programmed demolition of retired facilities and facilities which in the near term will be unable to meet mission requirements in a cost effective manner
- Construction of specific new buildings and the infrastructure required continuing to meet mission objectives.

The primary projects and resource requirements are described below.

New Buildings — Programmatic Research

The Molecular Foundry

The Molecular Foundry Building will include state-of-the-art materials characterization, manipulation and synthesis laboratories for studies of matter of nanometer dimensions. Materials at this size display unexpected properties that can be exploited in designing materials and devices with previously unattainable but critically required characteristics. These materials and devices will have a major impact on energy technologies and protection of the environment.

The Molecular Foundry will utilize LBNL's major user facilities — ALS, NCEM, and NERSC — for investigations of nanoscale materials and structures. These facilities will be instrumental in supporting the characterization, simulation and theory functions that will be a critical part of this program.

The Molecular Foundry Building will be a new, six story facility sited between Buildings 66 and 72 with a total gross area of approximately 94,500 gross square feet. Laboratory and office space in the new facility will be designed to support highly interdisciplinary studies in nanostructures involving the collaboration of experts in materials science, physics, chemistry, biology, molecular biology and engineering. Cleanroom laboratories with low vibration will be provided. The TEC of this Line Item Project is $83.7M. Construction is slated to begin in January 2004.

Genomes to Life

These Genomes to Life (GTL) program will enable scientists across all of biology to collect and analyze data on microbes and microbial proteins on an unprecedented scale.

Berkeley Lab performs a pivotal role in modeling of cellular systems in BER's GTL program and is committed to supporting DOE in performing the science that drives the GTL program and in its planning of new national facilities.

The Lab's growing and well regarded research in structural biology, computational crystallography and related functional genomics are prepared to fully support the GTL effort, the Laboratory is currently considering how it can best apply the Lab's GTL strengths and capabilities to serving the DOE and national needs in the era of systems biology and the facilities requirements of this program. Further discussion will be included in an upcoming Strategic Facilities Plan.

LUX

A major new facility is proposed in the area of femtosecond structural dynamics. The use of femtosecond optical lasers has revolutionized the study of many phenomena in solid state physics, chemistry and biology in the last 30 years. For example, the direct observation of intermediate conformations between reactant and product species, transition states, has been a major goal of physical chemists since the pioneering work of Eyring and Polanyi in the 1930's. However, it was recognized at the time that the lifetime of such states would be extremely short, in some cases on a timescale of a vibrational period, 100 fsec. Study of transition states was enabled by the invention of the modelocked cw dye laser in 1971, and development of laser techniques has led to the availability of a powerful range of spectroscopic tools with 10 fsec resolution across a spectral range from the ultra-violet to the infra-red. The timescale of a few picoseconds typically separates two classes of reaction dynamics, a longer timescale in which intermediate species occupy conformations around minima in the potential energy surface and are governed by Boltzman statistics, and a shorter timescale where atoms move collectively on the potential energy surface. An understanding of such excited state dynamics not only is of academic interest, but potentially shows us ways to manipulate chemical reactions at a fundamental level. The scientific significance of transition state chemistry was recognized with the award of the 1999 Nobel Prize in chemistry to A. H. Zewail. Many other examples of the importance of femtosecond optical studies exist, from laser driven solid-solid phase transitions to the study of photochemistry in biological systems, and clearly this area has grown into one of the most dynamic in modern science.

While great progress has been made, optical spectroscopy probes electronic states, whereas the information most needed is the motion of atoms. This is where x-ray techniques excel; x-ray diffraction (XRD) can give you direct 3d information, and x-ray absorption (EXAFS) gives you a radial distribution function of atomic positions. Combining XRD and EXAFS techniques with a source of 100 fsec x-rays would revolutionize many of the fields in which ultra-fast optical techniques are used. We propose to build such a source at Berkeley Lab. This work comes out of a program initiated in 1993 to establish Berkeley Lab as the leading center in structural dynamics worldwide using x-rays. Several sources have been built based on Thompson scattering and on the interaction of an intense laser beam with the ALS electron beam, and have been used to study a variety of dynamics, in particular the dynamics of ultra-fast melting. While these studies have been successful in the study of solid state dynamics in perfect single crystals, it is clear that to attack the wide range of science currently studied using optical techniques, we need to have a much more powerful source. The proposed facility will provide an increase in flux of more than 10^6 compared to our present ALS beamline, and in addition will provide for up to 8 simultaneously operating experimental stations.

The key researchers are now working to advance the design principles for this a new scientific user facility to support this research. A concept is based on several robust new technologies, 1) a high brightness photogun to produce intense short pulses of electrons, 2) a linear accelerator to accelerate electrons to high energy, 3) a recirculator to direct electrons several times through the same linac structure, 4) radio-frequency 'crab' cavities to kick the electron beam to produce a longitudinal tilting of the beam, and 5) optical pulse compression. All of these technologies are robust and well understood. For example, the superconducting linear accelerator is based on technology built for the TESLA high energy physics program in Germany and is commercially available. The rf photo-gun is

available from a number of sources developing free electron lasers. By using an assembly of these technologies, we can provide an ultra-fast x-ray facility with unprecedented performance in the environment of a national user facility.

X-ray free electron lasers (X-FEL) have been proposed that offer very high peak power and short pulse length, and so clearly it is important to understand the limitations and strengths of each type of source. The main point is that X-FELs being proposed and discussed are very much at the forefront of accelerator development, and for example will require a thousand-fold reduction in wavelength from present machines to become useful as a source for structural dynamics. There are many technical goals to be overcome before such machines would become user facilities, and it is likely that the first X-FELs will be only a stepping stone to a robust, dedicated user facility. While a linac source such as the one we aim to build at LBNL will have performance 1000 times lower in average flux than candidate X-FELs, it can be built today using robust technology as a multi-investigator user facility, and based on our work at LBNL pioneering ultra-fast structural measurements, the 10^6 higher flux compared to our present source will open up an enormous range of applications. Flux will not be an issue for many years in using such a source, and indeed it is a logical stepping stone on the way to sources of higher performance. The linac based source also has the advantage of absolute synchronization of laser pump and x-ray probe, and a pulse length of 50fsec, much shorter than that predicted for X-FELs. It is our belief that ultra-fast linac sources and X-FELs are complementary and both should be supported; the linac source provides a source that could be guaranteed to work using robust present day technology and would give outstanding performance compared to present day facilities, in the context of a national user facility. X-FELs will provide the ultimate in average and single pulse flux, but are at the leading edge of accelerator technology and therefore unlikely to be the basis of a robust user facility. X-FELs however must be developed in parallel with a linac based national user facility, in order to provide the route to even higher performance in the future.

It is anticipated that the facility would require a two-year construction schedule and could be constructed in 5 years on an existing site at Berkeley Lab. A full discussion of the facility will be included in a future Strategic Facilities Plan.

Removal of Retired Facilities

Consistent DOE Operating Funding is at the base of the Laboratory's efforts to remove retired facilities, facilities which were constructed to serve missions which are no longer supported by the DOE and which are not cost-effective or suitable for adaptive reuse.

These facilities are located at four "re-development" sites, two of these sites require only removal of abandoned accelerators and related equipment as the buildings are fundamentally sound and adaptive reuse is practical, the other two sites are complete demolition projects and will provide building sites for the construction of new modern research facilities.

88-Inch Cyclotron $19M – 50,000 gsf of building space reclaimed for use.

The Laboratory supports the continued operation of this accelerator facility. However, should DOE determine that it is no longer needed for this mission, LBNL seeks support from DOE to remove the accelerator and related equipment so that this building can be adapted for reuse to serve other mission purposes. The building has been surveyed and found to be in very good condition and, after removal of the accelerator and related equipment is suitable for adaptive reuse for other DOE missions. It is expected that this clearance effort would cost approximately $19 million and could be accomplished in about 4 years. The Laboratory is exploring reuse options for this building which is located on a prime site adjacent both to the main entrance to the Laboratory and to the very active Building 50-research complex.

Building 71 Accelerator $3M – 20,000 gsf of building space reclaimed for use. (scope and budget are under review)

DOE operations at this accelerator ceased ten-years ago and the accelerator portion of this otherwise useable building has been unusable for

this past decade. This project will remove the accelerator and related equipment so that this building can be reused for other mission purposes. It is estimated that this clearance effort would cost approximately $3 million and could be accomplished in one year.

Old Town $10M – 100,000 gsf of buildings demolished produces a 5.5 acre development site for modern new buildings. (scope and budget are under review)

The WWII-era buildings of the "Old Town" area of the Laboratory are not suitable for modern science and are no longer fully functional. The average age of these scientific buildings is 55-years; they have served the mission well and are now slated for removal to make a large 5.5-acre site available for modern research structures. These buildings are typically small wooden structures, yet they occupy prime sites that can be redeveloped to accommodate larger modern research facilities in line with current and future DOE mission requirements. The Laboratory proposes a retirement schedule for these structures that allows current building occupants to be relocated into more modern and appropriate space. The Laboratory proposes to reuse these building sites to construct modern multistory research facilities at these locations in order to seamlessly meet DOE's mission requirements for many decades. The proposed work includes demolition of Buildings 4, 5, 7, 14, 16 and 25 as well as smaller structures in the area, termination of utilities such that future projects can tap into the Laboratory's main infrastructure, and any required decontamination of the sites. The cost estimate is under review and may be updated in the next Strategic Facilities Plan.

The Bevatron $74.45M– 172,000 gsf of buildings demolished produces a 4.4 acre development site for modern new buildings.

This current project consists of dismantling, demolishing, and any required decontamination of the Building 51 Bevatron Complex. The work includes removal of the accelerator, shielding, buildings, related structures, and surface foundation. This site will then be productively used to meet DOE's emerging scientific missions. The abandoned Bevatron accelerator cannot be adaptively reused and should be removed. The Bevatron comprises 172,000 gsf of Laboratory space, about 10 percent of the space on the main site. Since it ceased operation in 1993, the Bevatron has been largely abandoned by the Department of Energy, with very limited funds for its dismantling. A key element of the facilities planning is the deconstruction of the Bevatron facility so this costly maintenance nuisance and impediment to site management can be eliminated, and the site used for DOE research and Laboratory needs. The Laboratory has provided a multiyear dismantling plan for the Bevatron. With funding consistent with the plan, the project will be completed in the 2015 time frame. It is possible, however, to accelerate this demolition schedule and complete demolition in the 2010 time frame; under this alternative scenario, the total project cost can be reduced.

Existing Facilities — Upgrade Projects

Berkeley Lab has effective maintenance and space improvement programs that work to allow researchers to use building space and other assets for the maximum number of years.

GPP Funded Multi-program Research-driven Upgrades to Portions of Building and Infrastructure

Most Berkeley Lab buildings can continue to meet research mission requirements under this program and the Resource Requirements matrix in Appendix A of this report describes a number of GPP projects that are currently at the core of this ongoing effort. However, unless GPP funding levels are increased, and the Laboratory is given the ability to re-program maintenance funds to permit appropriate upgrades when equipment is scheduled for replacement, this highly cost-effective program will not be able to accomplish the upgrades required for seamless mission performance – and additional Line Item Project funds will be required to address mission requirements. This later option is far less attractive as it does not support a seamless provision of research support services and it will

require that maintenance dollars be used for short-life "like-for-like" when research mission criteria clearly indicate that upgrades are appropriate. This approach does not serve the researchers well, and it is particularly costly as the short-life like-for-like replacements will be removed prior to the end of their useful life when Line Item funds become available to accomplish the necessary upgrades.

Line Item Funded Upgrades to Buildings and Infrastructure

A small number of existing buildings and sitewide utility systems are in fundamentally sound condition, but have major elements of their operating systems in need of major upgrades. These utility systems and buildings are identified for major infrastructure upgrades using Line Item Project funds. These utility systems and buildings are fundamentally sound and with major renovation of their operating systems to incorporate modern utilities and address current codes will have extended useful scientific lives of many more decades—at a fraction of the cost of new construction. These upgrade projects cannot be undertaken with GPP funds as they exceed the dollar cap for this funding source. Under DOE regulations, these few projects require use of Line Item Funds. The highest priority upgrade/rehabilitation projects are summarized below.

Line Item Funded Building Upgrades -

Building 77 Rehabilitation of Building Structure and Systems, Phs. II

Building 77 and the adjacent annex (77A) are multiprogram buildings that provide specialized technical services and assembly space. This project will correct mechanical, electrical and architectural deficiencies in buildings 77 and 77A. Both buildings house machine shop and assembly operations and have a combined net area of 68,000 sf in which production of highly sophisticated research components for a variety of DOE research projects takes place. Recent and current work includes precision machining, fabrication and assembly of components for the Advanced Light Source, DAHRT, the Spallation Neutron Source (SNS), and the ATLAS Detector. Infrastructure systems installed by this project include HVAC, power distribution, lighting, and noise absorption materials.

The improvements are necessary to satisfy urgent demands for high levels of cleanliness, temperature and humidity control, OSHA and reliability requirements. Phase II is funded at $13.36M as a FY 2003 project start.

Building 62 – Rehabilitation of Building Operating Systems

At 56,314 gsf, Building 62 is one of Berkeley Lab's largest multipurpose laboratory facilities. It is one of Berkeley Lab's primary research facilities, containing 30 laboratories and associated offices for the Materials Sciences, Environmental Energy Technologies, and Engineering Divisions. It houses significant research programs including high-temperature ceramics, electrochemistry and battery research, aqueous phase corrosion chemistry, wet-chemistry synthesis of magnetic materials, studies of spectral emissivity for roof coatings, X-ray scintillation studies, development of high-temperature superconducting materials, organic synthesis reactions, polymer synthesis, and development of instrumentation for both high-energy/nuclear physics detectors and biosciences applications. However, the scientific utility and flexibility of Building 62 is severely limited by the antiquated and deficient building systems that will be addressed by this project.

Building 62 urgently needs a comprehensive upgrade of its infrastructure systems to support current and future research demand for wet chemistry laboratories and clean rooms, and to provide for the health and safety of building occupants.

This project will replace aged wooden fumehoods and install a new centralized exhaust system. Additionally, to obtain constant air temperature and pressure conditions in the laboratories and provide for clean room capability, the project will modify the building heating, ventilation, and air conditioning (HVAC) system and install variable air volume controls in

the laboratories. The existing low-conductivity water (LCW) system will be expanded and upgraded to meet existing demand and furnish ample LCW for the new wet chemistry labs.

This Line Item Project has an estimated cost of $10M and is identified as a FY2006 project start.

Additional Line Item Funded Building Operating Upgrade Projects

In addition to the above two projects, the Laboratory proposes to upgrade/ rehabilitate three the building operating systems of three additional buildings during the term of this Plan. These are Buildings 74, 90 and 72, projects anticipated to start in FY's 2009, 2013 and 2013 respectively. These projects have been identified through the Laboratory's Condition Assessment Program and these upgrade projects proposed for timeframes when the current building operating systems will require major upgrades. Further details on these projects will be provided in Strategic Facility Plans prepared closer to the proposed start dates of these projects.

Line Item Funded Infrastructure Upgrades

Seismic Roadway and Utility Infrastructure Project

Portions of the Laboratory roadway system are prone to slip, slide, and fail during an earthquake. Moreover, roadways also serve as the Laboratory's primary utility corridors, and roadway failures can curtail important utility services to large portions of the Laboratory. This project will modify the roadway system to withstand seismic forces and preserve the integrity of the underlying utility infrastructure. This project will reinforce failure-prone areas, modify sections of the storm sewer system so that water flows do not exacerbate failure tendencies, and establish a route of Laboratory ingress and egress specifically designed to operate after a seismic event. Upon completion of this project, the Laboratory roadway, and the associated utility corridors, will not fail in a seismic event. This Line Item Project has an estimated cost of $15M and is identified as a FY2007 project start.

Sitewide Mechanical Utilities Rehabilitation

Berkeley Lab's infrastructure piping systems for natural gas, low-conductivity water (LCW), compressed air, and storm drainage serve over 100 buildings and facilities, including two major user facilities and four national user facilities. Corrosive soil conditions have caused leaks and failures in underground sections of these piping systems, resulting in excessive maintenance costs and the potential for serious disruptions of mission-critical research and hazards to life safety. By replacing some parts of these systems and installing cathodic protection for other parts, Rehabilitation of Site Mechanical Utilities, Phase 2, will economically prevent failures and arrest deterioration due to corrosion. This will extend system life and assure system performance and integrity during normal operations as well as during fire and earthquake emergencies.

This Line Item Project has an estimated cost of $10.2M and is identified as a FY2008 project start.

Existing Facilities — Environmental Remediation

Berkeley Lab is completing an assessment of its site survey to comprehensively identify any contaminated areas. Working with DOE, Berkeley Lab has advanced and expects to finalize a remediation plan in the near future.

Existing Facilities — Information Technologies Infrastructure

The purpose of Berkeley Lab's information technology infrastructure is to provide LBNL with efficient, effective, and innovative information technologies and services to enable world-class science. The range of services provided encompasses virtually all areas of modern computing and communications technology with

the exception of large-scale scientific computing. LBNL's strategic plan for IT infrastructure defines an integrated approach that builds upon the substantial technology benefits that LBNL has realized during the past decade and incorporates the modern technologies needed by LBNL to remain at the forefront of scientific research.

There are a number of specific requirements driven by user needs and technological opportunities that demand new or improved services categorized in the following major areas:

- Modernize aging infrastructure to increase science and business productivity, including reinventing library services and enhancing scientific computing support, "productivity" tools and network infrastructure
- Improve the utility of administrative systems through development of an integrated information portal to support timely decision making at all levels of the Lab's operations
- Improve the IT technical architecture to help assure that ITSD's resources are being directed in a consistent, cost-effective manner and to help assure that LBNL is achieving maximum benefits from its IT investments
- Establish and provide appropriate levels of protection, recovery, and continuity for all of the Lab's critical IT systems and data

The major infrastructure services are described below:

- Scientific Computational Services (e.g., mid-range computing, visualization)
- Productivity Services (e.g., email, desktop computing)
- Information Services (e.g., information systems, library)
- Presentation Services (e.g., publishing, conference tools)
- Protection (e.g., intrusion detection, firewalls, backups and archiving)
- Networking and Telecommunications (e.g., networking, telephones, remote access)
- Service Delivery Architecture (e.g., technical architecture, cost recovery, ISSM)

The majority of activities in each of these areas are ongoing production services. The largest strategic challenge faced is sustaining the effectiveness and dealing with the growth of these services. Meeting this challenge is particularly difficult in view of the rapid technology advancements and obsolescence that characterize IT functions. This impacts both the need to enable the Lab to benefit from substantial ongoing improvements in computer and communications hardware and software, and the need to continually develop high-quality staff who remain up to date with this technology.

To meet these information technology needs a significant short term increase in funding for GPE projects is requested (see Appendix A).

New Construction — SLI Facilities

General purpose facilities infrastructure is required to meet the needs of Berkeley Lab's scientific programs and to conduct operational and administrative support. This support includes the operations function; general engineering support; general computing support infrastructure; service needs for personnel, including environmental, health, and safety resources; property protection and emergency services; transportation services; cafeteria and conference services; and other infrastructure needs. The following building projects are important elements of the *Strategic Facilities Plan*.

User Support Building

The new User Support Building will provide critically needed modern research support space for users of the Advanced Light Source and other national user facilities. The building will support research in all disciplines (condensed matter physics; chemistry; materials; environmental, and earth sciences; biology; atomic and molecular physics; plasma sciences nanosciences, etc.). The new multiuser structure includes a high bay for assembly of experimental apparatus, as well as modern analytical laboratory and office space to support the over 2,000 scientific facility users. This space will support activities to prepare

experiments and to address other critical but short-term high-activity work activities. Demolition of substandard space and improved productivity combine for a payback of approximately seven years. This new 30,000 gsf building will replace Building 10, a wooden 15,575 gsf structure constructed as a service building during WWII, and which contains structural and life safety elements that restrict use. Building 10 can not be cost-effectively upgraded to serve modern science requirements. The estimated cost is $20M, CD-0 has been obtained and this project is on track to be a FY 2005 project start.

Research Support Building

The new 25,000 gsf (15,500 nsf, eff. 62%) office building will replace the structurally unsound and condemned Building 29 (which was demolished in 2002) and four associated condemned trailers. It will house ~70 people from a variety of essential research support functions that are currently scattered across the LBNL site including Library Services, Center for Science and Engineering, Laboratory Counsel, Technology Transfer, Procurement and Patent Department. Relocation of these functions from existing research buildings will free up ~ 20,000 gsf of research space and result in operational cost savings, efficient management and improved access for staff and guest researchers. Payback ~7 years. The estimated cost is $15.5M and the project is identified as a FY 2006 start.

Operations Building

The new 25,000 gsf (16,260 nsf, eff. 65%) office building will consolidate Facilities Division functions in a single location. The project will improve the efficiency of highly interdependent functions by co-locating personnel from various fragmented and dispersed site locations. Occupants will include Facilities Management, Administration, Planning, Project Management, Architecture and Engineering, and Operations & Maintenance personnel. The new facility will house ~100 people and eliminate overlap and duplication of administration and support functions, reduce travel time and strengthen communications. Payback ~ 6 years. The facility has an estimated cost of $16.0M and the project is identified as a FY 2007 start.

Replace Building 25 (Seismic Stability)

This new building will be constructed on the site of Building 25 (to be demolished separately prior to the start of this project due to seismic safety concerns) and allow approximately half of the Laboratory support staff who are currently housed in off site leased space to be located in a seismically safe building on the main site. This building will improve overall service quality while also reducing lease costs. Payback is approximately 6 years. The estimated cost is $20M and this project is identified as a FY 2008 start.

Environment, Health, and Safety (EH&S) Support Facility

Approximately 90 EH&S staff will be housed in this new 21,000 gsf (approx. 14,000 nsf, eff. 65%) facility. Consolidating these highly interactive staff will improve both internal and external EH&S communications, increase productivity, improve responsiveness, and further minimize potential risks of injury and environmental contamination across the site. This project will demolish an inefficient trailer-complex and replace it with a building that makes effective use of the site and which is suitable for EH&S staff and research. Increased productivity, the removal of an inefficient trailer complex, and the reassignment of space currently used by EH&S staff to address pressing research needs combine for a payback of approximately 5 – 6 years. The estimated cost is $15.5M.

Training Center and Auditorium

This new 14,000 gsf (9,000 nsf, eff. 65%) center will serve all research groups and support staff. The Laboratory currently has no suitable training/communication facility. The center will support effective communication both within and among research disciplines, it will also serve to coordinate group communications within virtual research activities. The new multi-purpose training facility will also allow staff to be efficiently trained in safe, secure, and efficient approaches to

their work, and support general conference and DOE tele-conference needs. Reduced travel and training costs, productivity gains, and reallocation of existing training spaces to research functions combine for a payback of less than 10-years. The estimated cost is $16.9M.

Site Support Service Facility

This new 13,000 gsf (approx. 8,500 nsf, eff. 65%) building and associated yard space will establish a single facility for the management and staging of Facilities Division field operations. Currently larger equipment is stored along streets, in parking lots and in general storage spaces where it is available; and smaller equipment and supplies are housed in temporary shelters and cargo containers and other otherwise un-usable locations across the site. The new facility will house ~ 55 staff adjacent to their equipment and supplies in an energy efficient facility that is fully compliant with OSHA and Clean Water Act regulations. Demolition of sub-standard units, recovery of parking and general storage spaces, and improved productivity combine for a payback of approximately 5 – 6 years. The estimated cost is $9.5M.

Replace Building 73

This new 19,000 gsf facility will provide approximately 8,000 nsf of multi-program research office and project-team space and 5,000 nsf of seminar space and short-term housing for visiting graduate students and post-docs (eff. 65%). Approximately 75 staff and graduate students will be accommodated. State of the art communications systems and project-team workspaces will be coupled with facilities specifically designed to assist graduate students and post-doc's to advance into the ranks of the nation's top DOE/SC scientists. This facility will replace a specialized research facility that is no longer used for its design purpose and which is not cost-effective to rehabilitate for other uses. Demolition of sub-standard space and improved productivity combine for a payback of approximately 5 – 6 years. The estimated cost is $14M.

Engineering Support Facility

This addition to Building 77A of 19,000 gsf (11,400 nsf, eff. 60%) of dry laboratory, computer, and office space for 38 Engineering Support Personnel will free up badly needed production and assembly space in the Building 77 complex. Consolidation of engineering functions at a single site will improve coordination, efficiency, and research support. Payback ~ 8 years. The estimated cost is $15.8M.

Third-Party Buildings

Research Office Building

In conjunction with the University of California Office of the President, the Laboratory has recently participated in an assessment of third-party funding options for the construction of new buildings. For the last several decades, the Laboratory has experienced steady growth in its research programs. Despite federal investments by the Department of Energy — especially the Office of Basic Energy Sciences and the Office of Biological and Environmental Research — in modern laboratory and office facilities, the University continues to operate Berkeley Lab with considerable outdated and overcrowded research and office space. While the University's third-party project will not address the total problem, it can relieve some of the pressures.

A building site for an office building has been selected, an architectural program has been developed, and a Request for Qualification (RFQ)/Request for Proposal (RFP) process has been completed for a 60,000 gsf office building. The proposed building site is a slope located adjacent to the Building 50 complex. The expected useful life of the building is 40 years. All basic site utilities exist in proximity to the site. If plans move forward, following a University Ground Lease to a developer, it is anticipated that the developer will prepare final design drawings, finance, construct, and operate the building. The Laboratory will fully lease the facility. Pending identification of an actual name, this project is designated Building 50X in reference to its proposed location near the Building 50 complex.

User Dormitory

Berkeley Lab's Advanced Light Source and National Center for Electron Microscopy (NCEM) are host to a growing number of users — more than 1,600 this year. Many other scientific visitors come to work with researchers in laboratories at other locations across the site, and although most computational scientist utilize NERSC Center facilities remotely, many visit NERSC Center scientific and support staff. In addition, beginning 2007, the Molecular Foundry is expected to host hundreds of users annually. All of these users need dormitories in close proximity to their research to effectively and efficiently conduct their experimental and scientific programs. Working with the University of California Office of the President, Berkeley Lab is developing the scope and approach for third-party support of a dormitory in order to meet these visiting user's short-term housing needs. A central "Civic Center" area location in close proximity to the Advanced Light and a short walk to NCEM, the Molecular Foundry and NERSC Center scientific staff has been identified as an ideal location for the proposed User Dormitory.

Multi-Party Funded Biosciences Research Building

The increased demands for research based on Berkeley Lab's multidisciplinary capabilities in the life sciences has created new needs for laboratories for the biological sciences. The Laboratory is exploring the development of a Biosciences Research Building potentially funded by a combination of foundations, the University of California, and third-party developers. The facility would provide for modern, efficient, and safe conduct of biological research programs at Berkeley Lab and enable quantitative biological science at the scale essential to advances in functional genomics, structural biology, cell biology of cancer, advanced microscopies, and computational biology. This new biology requires a modern facility where biologists, engineers, and computational scientists have a home and work closely together. The proposed facility will include approximately 30 laboratories, 80 offices and dedicated spaces for large shared instrumentation and computing resources in an arrangement that fosters interaction and collaboration. It will be located adjacent the core biosciences buildings in the east canyon and bring the dispersed life sciences programs together. The research conducted in the facilities would include Office of Science research and the complementary research sponsored by other agencies and foundations. The facility would not be a capital project of the Office of Biological and Environmental Research but would be a complementary and valued asset for possible future Genomes to Life facilities at Berkeley Lab sponsored by that office.

Environmental and Community Considerations

All plans and projects are assessed by the National Environmental Policy Act and California Environmental Quality Act review group for appropriate environmental documentation.

Facilities Division planning staff and Office of Planning and Communications planning staff participate in the Community Relations Advisory Group (CRAG), so that community issues can be considered and appropriate communications planned and implemented.

Berkeley Lab follows the Executive Order 13123 on "Greening of America" by promoting environmentally responsible design and construction. The impact of new construction is reduced through attention to sensitive site development, water and energy conservation, indoor air quality, waste reduction, and environmentally responsible building materials that minimize environmental impact throughout their life cycle.

Performance Metrics and Change Indicators

Although qualitative measures can often best describe performance; such measures are difficult to benchmark. The following quantitative performance-based metrics are developed to

address the use and condition of Laboratory assets relative to the research requirements.

Deficiency Correction Index (DCI)

$$DCI = \frac{\text{sq. ft. of replaced facilities (inc. demolition)}}{\text{sq. ft. rated "replacement needed" in FIMS}}$$

This metric provides direct assessment and benchmarking of efforts to correct the most obsolete buildings. Replacement of these structures is a paramount concern as these structures are significant ES&H problems, are exceptionally difficult research environments, and have significant negative impacts on overall site utilization rates.

Facilities Condition Index (FCI)

$$FCI = \frac{\$\text{deferred maintenance}}{\$RPV}$$

This widely used metric provides insight into the effectiveness of the maintenance program. This metric measures the relative cost of remedying maintenance deficiencies listed in the deferred maintenance backlog and conveys condition information.

Total Summary Condition Index (TSCI)

TSCI = the sum of Deferred Maintenance (DM) plus Rehab and Modernization Costs (RMC) divided by the facility's Replacement Plant Value (RPV).

Deferred Maintenance (DM) is defined as maintenance that was not performed when it should have been or was scheduled to be and which, therefore, is put off or delayed for a future period. It specifically excludes major 'like-in-kind' rehabs normally funded from GPP/GPE and line item projects.

Rehab and Modernization Cost (RMC) is defined as the total of all rehab and modernization costs, including needed function or capacity upgrades and the costs to bring the facility in compliance with all applicable building codes, ADA/UFAS, and Life Safety requirements, etc. as well as the costs to make facilities suitable for planned mission needs. These costs are normally funded via GPP/GPE or line item funding but could include large operating expense funded projects or Institutional General Plant Projects (IGPP). This metric provides insight into the overall management of facilities.

RESOURCES NEEDS SUMMARY

Science Lab Infrastructure (SLI) Support

Historically, SLI funding at LBNL has been an average of approximately $3.8M per year. Over the period of FY1998-FY2002, the funding level has been only slightly above this average level, at $4.2M per year. The profile of funding has been irregular, including no new starts in FY 1994, FY 1995, FY 1997, and FY 2000. The following SLI chart provides more detail.

While Berkeley Lab's funding trend has increased slightly in actual dollars, this program has not been able to address pressing concerns at current funding levels. Moreover, we note that the SLI budget has been cut almost in half over the last 15 years. The impact of these cuts is even greater when the impacts of inflation are considered.

The SLI program is the only available strategic capital renewal program in the Office of Science for non-programmatic infrastructure. Funding levels should be increased or restored (corrected for inflation) in order to begin to achieve the infrastructure renewal needed at the multiprogram labs.

General Plant Projects (GPP)

As illustrated in the following GPP chart, GPP funds have been relatively flat ($3.3M to $3.5M[1] in actual dollars) at LBNL since 1993. However, relative to FY 1993, in FY 2003 the purchasing power of these funds will have dropped some 30% to about $2.6M due to

[1]The FY2000 GPP allocation of $3.5M is used in this comparison even though it was necessary to convert $530K to operating funds for the completion of the Oakland Scientific Facility.

inflation alone. This inflation-induced shortfall caused by a flat funding scenario has resulted in a serious backlog of mission critical projects.

GPP funding is extremely valuable to the Laboratory. Under DOE regulations, this type of funding is the only one the Laboratory can use to seamlessly upgrade facilities to meet evolving research requirements. These funds are critical to maximizing the utility of existing assets.

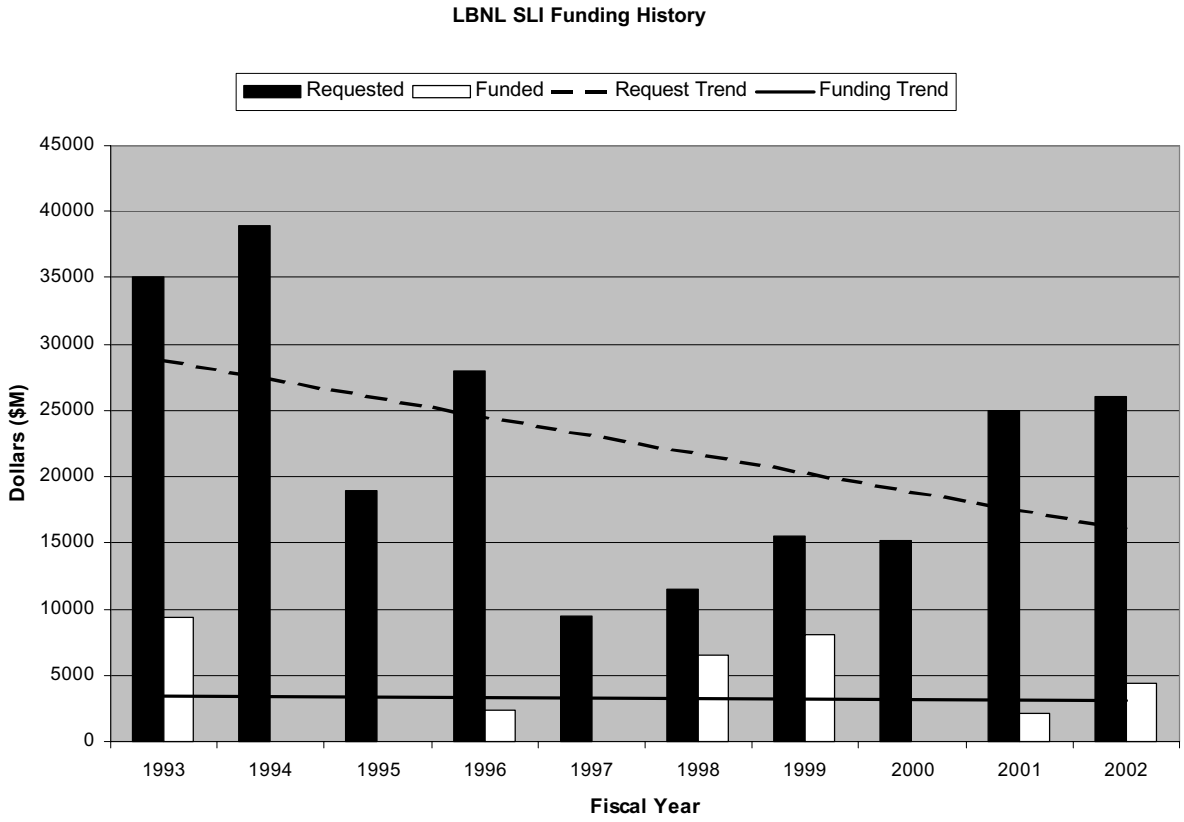
A three-year increase of GPP funding to the $12M-15M range will allow the current backlogged priorities to be addressed, and consistent funding at $10.5M per year would allow the Lab to continue to upgrade and reuse facilities to meet all scientific mission requirements. Without this increase, these projects would require 20+ years to complete and the schedule for completion of the *Strategic Facilities Plan* would be negatively impacted.

General Purpose Equipment (GPE)

Institutional GPE funding has also been historically flat at LBNL, ranging from $1.87M in FY 1993 to $1.95M for the last several years.

The actual spending power of these GPE dollars has declined approximately 30% during this period. The following GPE chart illustrates the actual allocations and purchasing power of those allocations adjusted for inflation only.

The limited funding has severely restricted our ability to implement a reasonably full program of modernization and upgrades. To meet the research objectives outlined in this plan and to recover from the inflation-induced shortfalls caused by the flat funding scenario, a short-term increase of GPE funding is needed.


LBNL SLI Funding History
Requested
Funded
Request Trend
Funding Trend
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40000
35000
30000
25000
20000
15000
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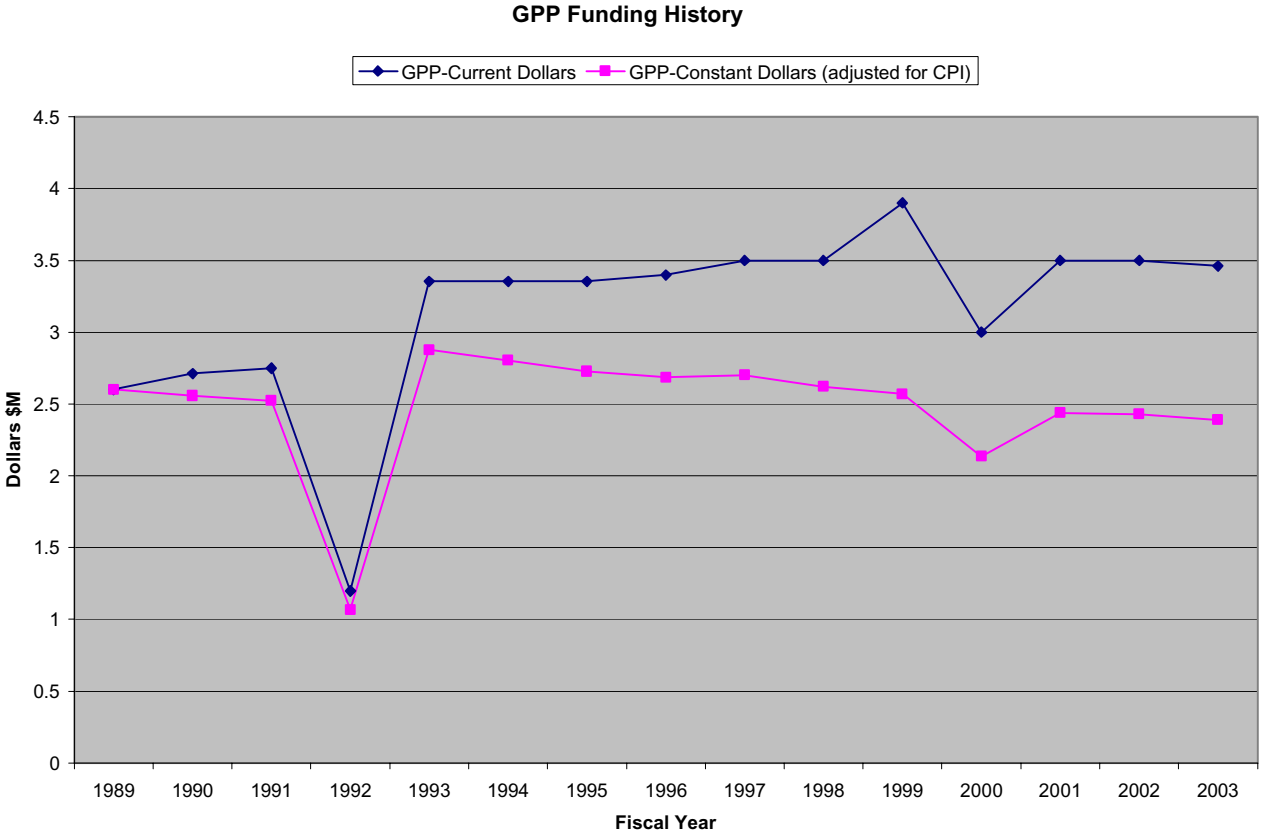
5000
0
Dollars ($M)
1993
1994
1995
1996
1997
1998
1999
2000
2001
2002
Fiscal Year


GPP Funding History
GPP-Current Dollars
GPP-Constant Dollars (adjusted for CPI)
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4
3.5
3
2.5
2
1.5
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0.5
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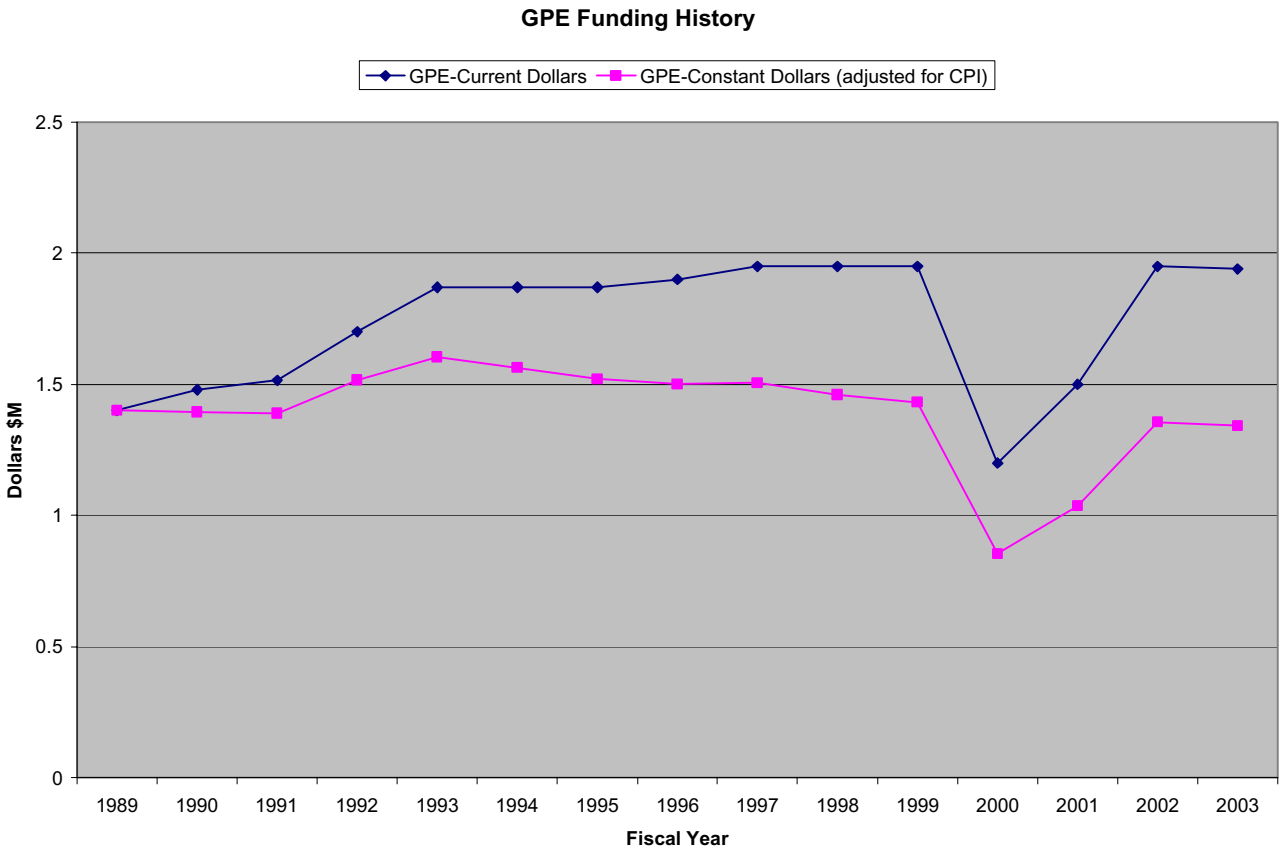
2002
2003
Fiscal Year



Real Property Maintenance

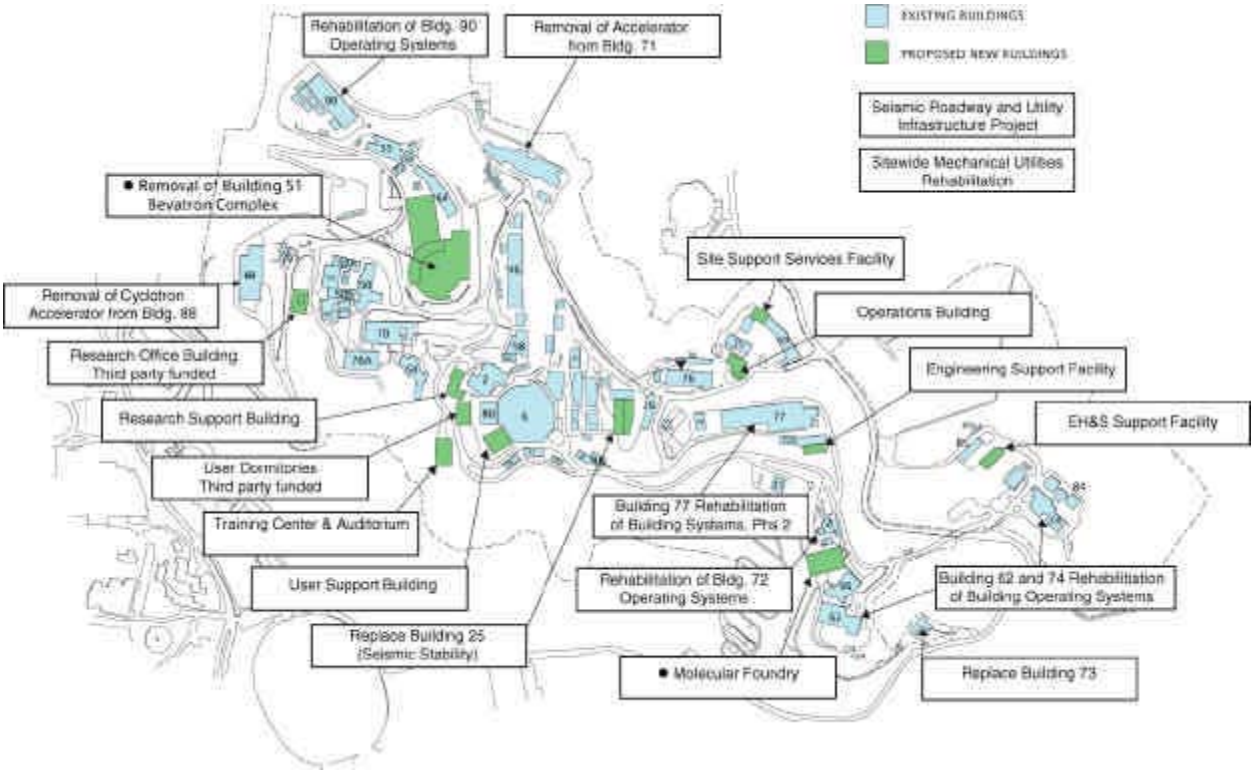
As modernization efforts proceed to meet the current and future research needs at LBNL it is expected that maintenance and operations costs will also rise. Currently we have been doing a good job of maintaining the existing old facilities with the funding provided. However, as expectations rise, the frequency and severity of complaints are expected to increase as the mismatch between obsolete and modern facilities increases. Additionally, as more modern buildings are provided with more sophisticated mechanical and electrical systems, it is expected that the associated maintenance costs will rise. Maintenance costs are therefore expected to increase as projected due to either aging facilities during rising expectations or modernized facilities with more sophisticated services.

The latest projections indicate that the approximately $1.5M annually budgeted from operating funds may need to be increased to approximately $2.0M in order to complete priority planned-maintenance projects and keep potential backlog growth under control.

Operating Funding

For budget purposes, the “non-cap” base level at LBNL has remained at approximately $2.9M for the past five years. Annually, $800K is reserved for emergencies, laboratory initiated relocations, and ES&H corrections, leaving $2.1M for requested projects. This provides very little opportunity to address the over 100 needs totaling over $25M, that are currently unfunded in the Project Call Database. Among projects on the backlog are wildland fire management and seismic upgrades, both of which can be only partially funded each year; replacements of outdated electrical and mechanical systems that are outside of GPE scope; and numerous projects to improve the utilization or quality of our office and laboratory space, a significant problem due to the aging and overcrowding of our buildings.

Appendix A – Resource Needs Spreadsheet



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Appendix B — Proposed Major Construction Map – DOE Funded SLI and Programmatic Line Item Projects and Third-Party Funded Projects

LBNL Resource Requirements

June 6, 2002

DRAFT 2

$ in Millions

Project/Activity	GSF New Const.	GSF Removed	Net New GSF	Vision/ Goal	TEC	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	Simple Payback *	TEC ($ / gsf)	Const. Cost ($ /gsf) **
REAL PROPERTY MAINTENANCE																					
Real Property Maintenance ***						7.53	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26			
% of Replacement Plant Value (RPV)						1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0			
GENERAL PLANT PROJECTS AND EQUIPMENT																					
General Plant Projects (GPP):																					
Bldg. 6 Second Floor Office and Lab Space (FY 2000 start)				M, O, W	4.99	1.26															
Bldg. 77 142C Clean Room				M, O, W	1.35	1.35															
Bldg. 2 Ventilation Upgrade				E, M, W	0.60	0.35	0.15														
Radio Communication System				E, M, O, W	0.85	0.08	0.57	0.20													
Bldg. 83 Remodel Culture Room (PGPP)				E, M, O, W	0.20		0.20														
Bldg. 74 Renovate Animal Area				M, O, W	0.07		0.07														
Bldg. 71 Modify Caves L & M and Seismically Upgrade				M, O, W	1.25		1.25														
Bldg. 2 Laboratory Upgrade				M, O, W	0.90		0.90														
Bldg. 77 Install Sump Pump				M, O, W	0.04		0.04														
Bldg. 6 Rm. 2145 Install Ventilation				E, M, O, W	0.03		0.03														
Bldg. 90 HVAC System Upgrade				E, M, O, W	0.77		0.20	0.57													
Bldg. 76 Dust Collection System Upgrade				E, M, W	0.20		0.13	0.07													
Bldg. 6 Enclose Offices				M, W	0.35			0.35													
Bldg. 58 Expansion	500	0	500	M, O, W	0.75			0.75												1,500	
Bldg. 50 Rm 2265 Convert to Office Space				M, W	0.25			0.25													
Bldg. 70A Rm 2245 Convert to Wet Lab				E, M, O, W	0.50			0.50													
Bldg. 70A Rm 2253 Convert to Cell Culture Lab				M, O, W	0.25			0.25													
Bldg. 64 Rm 163 Upgrade High Bay Heating				M, O, W	0.07			0.07													
Bldg. 73 Rm 001 Convert to NMR Lab				M, O, W	0.38			0.38													
Bldg. 64 Rm 150 Create Lab and Office Space				M, O, W	1.40			0.90	0.60												
Bldg. 70A Superconducting Detector Array Laboratory				E, M, O, W	2.00			0.50	1.50												
Bldg. 6 Rm 1000 Electrical Power Upgrade				M, O, W	0.08				0.08												
Bldg. 50 - Construct Communication Grid Center				M, O, W	1.50				1.50												
Bldg. 37 Install New Low Conductivity Water Cooling Tower				M, O, W	1.50				1.50												
Bldg. 58A Extension	1,950	0	1,950	E, M, O, W	2.95				2.95											1,500	
Bldg. 10 Improve Staging And Vacuum Assembly Facility				E, M, O, W	1.00				1.00												
Bldg. 70 Improve And Expand Existing Vacuum System				E, M, W	0.21				0.21												
Upgrade 2MW Standby Generator Connection to Electrical Distribution System				E, M, O, W	0.75				0.75												
Bldg. 88 Area - Create Parking Lot on Fill Site				M, W	0.70				0.70												
Construct Sensitive Instrument Facility				M, O, W	3.00				3.00												
Bldg. 62 Highbay Conversion to Laboratory				M, O, W	3.00				3.00												
Construct Isolation Kennel	400	0	400	M, O, W	0.40				0.40											1,000	
Blackberry Canyon - Create Fill Site to Expand Parking Lot				M, O, W	0.50				0.50												
Expand Cooling Tower Capacity Lee Road Area				M, O, W	1.50					1.50											
Bldg. 71 Highbay Improvements				M, O, W	3.70					3.70											
Construct Medium Height Bay Research Bldg.	10,000	0	10,000	M, O, W	4.50					4.50										450	
Upgrade Intersection of Lawrence Road, Glaser Road and Road "S"				E, M, O, W	0.70					0.70											
Bldgs. 62/66 - Conversion of Support Space to Wet Lab				E, M, O, W	2.00					2.00											
Bldg. 50 Office Reconfiguration				M, O, W	4.00					2.00	2.00										
Realignment of Grizzly Gate Road				E, M, O, W	3.70						3.70										
Completion of Storm Drain Piping Upgrade				E, M, O	2.16						2.16										
Construct SNAP Control Room and Support Facilities				M, O, W	0.80						0.80										
NCEM Addition	5,000	0	5,000	M, O, W	4.00						4.00									800	
Improve Access Road on West and South sides of Bldg. 70A				E, M, O, W	1.00							1.00									
Upgrade Laboratories in Bldg. 70				M, O, W	1.50							1.50									
Upgrade Laboratories in Bldg. 70A				M, O, W	1.50							1.50									
Bldg. 88 - Upgrade Electrical Systems				E, M, O, W	1.70							1.70									
Fill Draw to Southwest of Bldg. 70A				M, O, W	0.80							0.80									
Upgrade of ALS Access - Convert Pathway to Roadway				E, M, O, W	1.50							1.50									
Construct Parking Area on Fill Site between Operations and Engineering Areas				E, M, O, W	1.00							1.00									
Upgrade Unit Substations				M, O, W	1.10							0.54	0.56								
Realign McMillan Road Intersection at Chamberlain Road				E, M, O, W	1.20								1.20								
Improve Ventilation in 50/50A				E, M, O, W	4.80								4.80								
Storm Drain Upgrades				E, M, O, W	2.50								2.50								
Upgrade Civic Center Assembly Area				M, O, W	0.50									0.50							
Addition to Cafeteria	8,000	0	8,000	E, M, O, W	4.50									4.50						562	
Construct Primary Shuttle Bus Transfer Station in Civic Center				M, O, W	0.50									0.50							
Widen and Straighten Cyclotron Road at Main Entrance				E, M, O, W	3.70									3.70							
Complete Office Addition at Bldg. 88	4,600	0	4,600	E, M, O, W	2.00										2.00					435	
Bldg. 70 Rm 108 Fumehood Exhaust Fan Upgrade				E, M, O, W	0.01										0.01						
Bldg. 70 Improve and Expand Vacuum System				M, O, W	0.21										0.21						
Extend Sanitary Sewer Line between Chicken Creek and Centennial Drive				E, M, O, W	1.50										1.50						
Road and Utility Corridor Improvements in Chicken Creek				E, M, O, W	1.50										1.50						
Bldg. 90 - Construct Large Communication Grid Space				M, O, W	3.10										3.10						
Construct Large Vehicle Wash Facility	2,000	0	2,000	E, M, O, W	0.93										0.93					465	
Compressed Air Distribution System Upgrade				M, O, W	0.18										0.18						
Bldg. 80 Provide Process Cooling Water Backup				M, O, W	0.03											0.03					
Bldg. 34 Add Chilled Water Expansion Tank				M, O, W	0.02											0.02					
Bldg. 55 Area Office/Lab Expansion				M, W	4.90											4.90					
Upgrade Upper East Canyon Egress Roadway				M, O, W	1.50											1.50					
Bldg. 70 Upgrade Bldg. Exhaust System				E, M, O, W	2.50											2.50					
Bldg. 70A Upgrade Bldg. Exhaust System				E, M, O, W	2.80												2.80				
Bldg. 72 Add Two Chilled Water Storage Tanks				M, O, W	0.02												0.02				
Natural Gas Distribution System Upgrade				E, M, O, W	1.10												1.10				
Create Corridor Connecting the Main Floors of Bldgs. 66 and 62				E, M, O, W	1.00												1.00				
Upgrade HVAC System in Bldgs. 50B, 50E and 50F				E, M, O, W	4.60												4.60				
Bldg. 54 - Upgrade Mechanical Systems				M, O, W	2.30													2.30			
Low Conductivity Water System Upgrade				E, M, O, W	4.30													4.30			
Lawrence Road Sightline Improvements				E, M, O, W	2.80													2.80			
Other GPP Priorities						0.00	0.00	0.00	0.00	0.00	0.00	0.96	1.44	1.30	1.06	1.55	0.98	1.10			
Total GPP:	32,450	0	32,450			3.04	3.53	4.79	17.69	14.40	12.66	10.50	10.50	10.50	10.50	10.50	10.50	10.50			
General Plant Equipment (GPE):																					
Information Technology: Conferencing and Collaboration Equipment				M, O, W				0.3	0.2	0.3	0.2	0.3	0.1		0.1			0.1			
Information Technology: Digital Libraries and Information Management				M, O, W				0.2	0.2	0.2	0.1			0.1			0.1				
Information Technology: "Network Smart" Equipment Infrastructure				E, M, O, W				0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3			
Information Technology: Networking Facilities Needs				E, M, O, W		0.8	1.1			8.0	8.0	8.0	8.0	8.0							
Other GPE Priorities						1.3	0.8	11.8	9.4	2.2	2.4	2.4	2.6	3.1	11.1	11.2	11.1	11.1			
Total GPE:						2.1	1.9	12.6	10.1	11.0	11.0	11.0	11.0	11.5	11.5	11.5	11.5	11.5			
LINE ITEM CONSTRUCTION:																					
Program Related Projects:																					
Molecular Foundry	94,500	0	94,500	M, O, W	83.70			83.70												886	
E-Lab	29,000	0	29,000	E, M, O, W	19.00				19.00											655	
Genome to Life Proteomics and Computational Sciences Facility	50,000	0	50,000	E, M, O, W	45.00					45.00										900	
Femtosecond Accelerator	TBD			E, M, O, W	TBD						TBD										
Center for Atomic, Molecular & Chemical Science	33,000	15,173	17,827	M, O, W	30.00						30.00									909	
Stable Beam Facility	TBD			M, O, W	TBD						TBD										
Biosciences Research Bldg.	50,000	7,533	42,467	E, M, O, W	50.00							50.00								1,000	
Energy Sciences Bldg.	30,000		30,000	E, M, O, W	18.00								18.00							600	
Computational Sciences Research Facility	50,000		50,000	E, M, O, W	25.00									25.00						500	
Accelerator Research Support Bldg.	25,000	5,168	19,832	E, M, O, W	25.00										25.00					1,000	
Astrophysics Research Facility	40,000		40,000	M, O, W	40.00											40.00				1,000	
Earth Sciences Center	30,000		30,000	E, M, O, W	20.00												20.00			667	
Total Programmatic Line Item Projects:	451,500	27,874	403,626			0.00	0.00	83.70	19.00	45.00	30.00	50.00	18.00	25.00	25.00	40.00	20.00	0.00			
Science Lab Infrastructure (SLI) Projects:																					
Bldg. 77 Rehabilitation, Phs. 1 (FY 1999 start)				E, M, O, W	8.00	1.11															
Sitewide Water Distribution Upgrade, Phase 1				E, M, O, W	8.30	1.00	4.40	2.90													
Bldg. 77 Rehabilitation of Bldg. Structure & Systems, Phs 2				E, M, O, W	13.36			13.36													
Research Support Bldg.	25,000	15,475	9,525	M, O, W	15.00				15.00										6.8	600	
Bldg. 62 - Upgrade of Bldg. Operating Systems				M, O, W	11.50					11.50											
Replace Bldg. 7	30,000	21,459	8,541	E, M, O, W	12.00					12.00										400	
Bldg. 74 - Rehabilitation of Bldg. Operating Systems				E, M, O, W	18.00						18.00										
Operations Bldg.	25,000	16,975	8,025	M, O, W	15.00						15.00								5.7	600	
Engineering Support Facility	19,000	0	19,000	M, O, W	15.30							15.30								805	
Replace Bldg. 25 (Seismic Stability)	25,000	27,975	-2,975	E, M, O, W	20.20							20.20								800	
Environmental, Health and Safety Support Facility	21,000	3,603	17,397	M, O, W	16.40								16.40							781	
Training Center and Auditorium	14,000	0	14,000	M, O, W	16.00									16.00						1,100	
Site Support Services Facility	13,000	4,000	9,000	E, M, O, W	9.50										9.50					731	
Replace Bldg. 73	19,000	4,631	14,369	E, M, O, W	14.00											14.00				737	
Rehabilitation of Bldg. 90 Operating Systems				E, M, O, W	18.00												18.00				
Rehabilitation of Bldg. 72 Operating Systems				E, M, O, W	12.00													12.00			
Total SLI Line Item Projects:	191,000	94,118	96,882			2.11	4.40	16.26	15.00	23.50	33.00	35.50	16.40	16.00	9.50	14.00	18.00	12.00			
THIRD PARTY FUNDED BUILDINGS:																					
50X ****	60,000	0	60,000	M, O, W	TBD																
Total Third Party Projects:	60,000	0	60,000																		
OPERATING FUNDING NEEDED FOR REMOVAL OF RETIRED FACILITIES:																					
Removal of Bldg. 51 Bevatron Complex	0	164,000	-164,000	E, M, O, W	74.45		2.50	0.95	10.00	10.00	10.00	10.00	10.00	10.00	11.00						
Total Operating Funded Removal of Retired Facilities:	0	164,000	-164,000				2.50	0.95	10.00	10.00	10.00	10.00	10.00	10.00	11.00						

Sub-Totals By Category:

	GSF New Const.	GSF Removed	Net New GSF
Total Change in Gross Square Feet of DOE Assets (GSF):	654,950	285,992	368,958

Total GPP/GPE/GPF ($M):					7.25	9.83	33.65	42.79	48.90	56.66	57.00	37.90	38.00	31.50	36.00	40.00	34.00				
Total Operating Funding Needed for Removal of Retired Facilities ($M):					0.00	2.50	0.95	10.00	10.00	10.00	10.00	10.00	10.00	11.00	0.00	0.00	0.00				
Total Operating Funding for Real Property Maintenance ($M):					7.53	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26	7.26				
Programmatic Modernization Projects ($M)					0.00	0.00	83.70	19.00	45.00	30.00	50.00	18.00	25.00	25.00	40.00	20.00	0.00				
Third Party Funding ($M)					TBD																

Information Technology (IT) Needs Crosscut ($M)

Operating Funds: Networking Facilities Needs (GPE)							0.3	0.2	0.3	0.2	0.3	0.1		0.1				0.1			
Information Technology: Conferencing and Collaboration Equipment (GPE)							0.2	0.2	0.2	0.1			0.1				0.1				
Information Technology: Digital Libraries and Information Management (GPE)							0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3	0.3			
Information Technology: "Network Smart" Equipment Infrastructure (GPE)					0.8	1.1			8.0	8.0	8.0	8.0	8.0								
Total IT:					0.8	1.1	0.8	0.7	0.8	8.0	8.0	8.4	8.4	0.4	0.3	0.4	0.4				

KEY to Vision/Goals : E = Environmental Health & Safety
M = Mission
O = Maintenance & Operations
W = Working Environment

Note: GSF = Gross Square Feet
TBD = To Be Determined
$M = Million Dollars
$B = Billion Dollars

Footnotes:

* = Payback has been calculated for both the Operations Bldg. and the Research Support Bldg..
Based on these calculations, we anticipate that other building projects will also have simple paybacks in the 5 to 10 year range

** = Construction Cost is being calculated.

*** = Per DOE budget definition, these figures do not include grounds, pest control etc. The FY 2001 figure including these activities is 7.97M.
The FY 2002 - 2013 figures are consistent with the budget forecast submittal of FY 2002, these figures are flat as LBNL is evaluating maintenance activities and SAFA 6 guidelines; it is anticipated that this section of the table will be modified in the 2003 SFP.
The FIMS RPV figure ($1.253B in FY 2002) is similarly held constant pending conclusion of this evaluation.

**** = Request for Qualifications review completed in FY 2002. Request for Proposals to be issued in FY 2002.